GNU dbm

A Database Manager

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1 Copying Conditions.

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2 Introduction to GNU dbm.

GNU dbm (gdbm) is a library of database functions that use extensible hashing and works similar to the standard UNIX dbm functions. These routines are provided to a programmer needing to create and manipulate a hashed database. (gdbm is *NOT* a complete database package for an end user.)

The basic use of gdbm is to store key/data pairs in a data file. Each key must be unique and each key is paired with only one data item. The keys can not be directly accessed in sorted order. The basic unit of data in gdbm is the structure:

```
typedef struct {
           char *dptr;
           int  dsize;
         } datum;
```

This structure allows for arbitrary sized keys and data items.

The key/data pairs are stored in a gdbm disk file, called a gdbm database. An application must open a gdbm database to be able manipulate the keys and data contained in the database. gdbm allows an application to have multiple databases open at the same time. When an application opens a gdbm database, it is designated as a `reader` or a `writer`. A gdbm database can be opened by at most one writer at a time. However, many readers may open the database simultaneously. Readers and writers can not open the gdbm database at the same time.

3 List of functions.

The following is a quick list of the functions contained in the `gdbm` library. The include file `gdbm.h`, that can be included by the user, contains a definition of these functions.

```
#include <gdbm.h>

GDBM_FILE gdbm_open(name, block_size, flags, mode, fatal_func);
void gdbm_close(dbf);
int gdbm_store(dbf, key, content, flag);
datum gdbm_fetch(dbf, key);
int gdbm_delete(dbf, key);
datum gdbm_firstkey(dbf);
datum gdbm_nextkey(dbf, key);
int gdbm_reorganize(dbf);
void gdbm_sync(dbf);
int gdbm_exists(dbf, key);
char *gdbm_strerror(errno);
int gdbm_setopt(dbf, option, value, size);
int gdbm_fdesc(dbf);
int gdbm_export (GDBM_FILE, const char *, int, int);
int gdbm_export_to_file (GDBM_FILE dbf, FILE *fp);
int gdbm_import (GDBM_FILE, const char *, int);
int gdbm_import_from_file (GDBM_FILE dbf, FILE *fp, int flag);
int gdbm_count (GDBM_FILE dbf, gdbm_count_t *pcount);
int gdbm_version_cmp (int const a[], int const b[]);
```

The `gdbm.h` include file is often in the `/usr/include` directory. (The actual location of `gdbm.h` depends on your local installation of `gdbm`.)

4 Opening the database.

GDBM_FILE gdbm_open (*const char *name, int block_size, int flags, int mode, void (*fatal_func)(const char *)*) [gdbm interface]

Initializes gdbm system. If the file has a size of zero bytes, a file initialization procedure is performed, setting up the initial structure in the file.

The arguments are:

name The name of the file (the complete name, gdbm does not append any characters to this name).

block_size It is used during initialization to determine the size of various constructs. It is the size of a single transfer from disk to memory. This parameter is ignored if the file has been previously initialized. If the value is less than 512, the file system block size is used instead. The size is adjusted so that the block can hold exact number of directory entries, so that the effective block size can be slightly greater than requested. However, if the 'GDBM_BSEXACT' flag is set and the size needs to be adjusted, the function will return with error status, setting the 'gdbm_errno' variable to 'GDBM_BLOCK_SIZE_ERROR'.

flags If flags is set to 'GDBM_READER', the user wants to just read the database and any call to gdbm_store or gdbm_delete will fail. Many readers can access the database at the same time. If flags is set to 'GDBM_WRITER', the user wants both read and write access to the database and requires exclusive access. If flags is set to 'GDBM_WRCREAT', the user wants both read and write access to the database and wants it created if it does not already exist. If flags is set to 'GDBM_NEWDB', the user want a new database created, regardless of whether one existed, and wants read and write access to the new database.

The following may also be logically or'd into the database flags: 'GDBM_SYNC', which causes all database operations to be synchronized to the disk, 'GDBM_NOLOCK', which prevents the library from performing any locking on the database file, and 'GDBM_NOMMAP', which disables the memory mapping mechanism. The option 'GDBM_FAST' is now obsolete, since gdbm defaults to no-sync mode.

If this flag is set and the requested *block_size* cannot be used without adjustment, gdbm_open will refuse to create the databases. In this case it will set the 'gdbm_errno' variable to 'GDBM_BLOCK_SIZE_ERROR' and return 'NULL'.

If the host 'open' call (see Section "open" in *open(2) man page*) supports the 'O_CLOEXEC' flag, the 'GDBM_CLOEXEC' can be or'd into the flags, to enable the close-on-exec flag for the database file descriptor.

mode File mode (see Section "change permissions of a file" in *chmod(2) man page*, and see Section "open a file" in *open(2) man page*), which is used if the file is created).

fatal_func A function for `gdbm` to call if it detects a fatal error. The only parameter of this function is a string. If the value of '`NULL`' is provided, `gdbm` will use a default function.

The return value, is the pointer needed by all other functions to access that `gdbm` file. If the return is the '`NULL`' pointer, `gdbm_open` was not successful. The errors can be found in `gdbm_errno` variable (see Chapter 18 [Variables], page 27). Available error codes are discussed in Chapter 19 [Error codes], page 29.

In all of the following calls, the parameter *dbf* refers to the pointer returned from `gdbm_open`.

`GDBM_FILE gdbm_fd_open` (*int* ***fd***, *const char* ****name***, *int* ***block_size***, *int* ***flags***, *int* ***mode***, *void* (**fatal_func*)(*const char* **)*) [gdbm interface]

Alternative function for opening a GDBM database. The *fd* argument is the file descriptor of the database file obtained by a call to `open`(2), `creat`(2) or similar funcionss. The descriptor is not dup'ed, and will be closed when the returned GDBM_FILE is closed. Use `dup`(2) if that is not desirable.

`int gdbm_copy_meta` (*GDBM_FILE* ***dst***, *GDBM_FILE* ***src***) [gdbm interface]

Copy file ownership and mode from *src* to *dst*.

5 Closing the database.

It is important that every file opened is also closed. This is needed to update the reader/writer count on the file:

`void gdbm_close (`*GDBM_FILE dbf*`)` [gdbm interface]

This function closes the `gdbm` file and frees all memory associated with it. The parameter is:

dbf The pointer returned by `gdbm_open`.

6 Number of Records

`int gdbm_count` (*GDBM_FILE* `dbf`, *gdbm_count_t* *`pcount`) [gdbm interface]

Counts number of records in the database *dbf*. On success, stores it in the memory location pointed to by *pcount* and return 0. On error, sets `gdbm_errno` (if relevant, also `errno`) and returns -1.

7 Inserting and replacing records in the database.

`int gdbm_store` (*GDBM_FILE* `dbf`, *datum* `key`, *datum* `content`, *int* `flag`) [gdbm interface]

The function `gdbm_store` inserts or replaces records in the database.

The parameters are:

dbf The pointer returned by `gdbm_open`.

key The search key.

content The data to be associated with the key.

flag Defines the action to take when the key is already in the database. The value '`GDBM_REPLACE`' (defined in `gdbm.h`) asks that the old data be replaced by the new *content*. The value '`GDBM_INSERT`' asks that an error be returned and no action taken if the *key* already exists.

This function can return the following values:

-1 The item was not stored in the database because the caller was not an official writer or either *key* or *content* have a '`NULL`' '`dptr`' field.

Both *key* and *content* must have the '`dptr`' field be a non-'`NULL`' value. Since a '`NULL`' '`dptr`' field is used by other functions to indicate an error, it cannot be valid data.

+1 The item was not stored because the argument *flag* was '`GDBM_INSERT`' and the *key* was already in the database.

0 No error. The value of *content* is keyed by *key*. The file on disk is updated to reflect the structure of the new database before returning from this function.

If you store data for a *key* that is already in the data base, `gdbm` replaces the old data with the new data if called with '`GDBM_REPLACE`'. You do not get two data items for the same `key` and you do not get an error from `gdbm_store`.

The size in `gdbm` is not restricted like `dbm` or `ndbm`. Your data can be as large as you want.

8 Searching for records in the database.

`datum gdbm_fetch` (*GDBM_FILE* **`dbf`**, *datum* **`key`**) [gdbm interface]

Looks up a given *key* and returns the information associated with it. The '`dptr`' field in the structure that is returned points to a memory block allocated by `malloc`. It is the caller's responsibility to free it when no longer needed.

If the '`dptr`' is '`NULL`', inspect the value of the `gdbm_errno` variable (see Chapter 18 [Variables], page 27). If it is '`GDBM_ITEM_NOT_FOUND`', no data was found. Any other value means an error occurred. Use `gdbm_strerror` function to convert `gdbm_errno` to a human-readable string.

The parameters are:

dbf The pointer returned by `gdbm_open`.

key The search key.

An example of using this function:

```
content = gdbm_fetch (dbf, key);
if (content.dptr == NULL)
  {
    fprintf(stderr, "key not found\n");
  }
else
  {
    /* do something with content.dptr */
  }
```

You may also search for a particular key without retrieving it:

`int gdbm_exists` (*GDBM_FILE* **`dbf`**, *datum* **`key`**) [gdbm interface]

Checks whether the *key* exists in the database *dbf*.

If *key* is found, returns '`true`' ('`1`'). If it is not found, returns '`false`' ('`0`') and sets `gdbm_errno` to '`GDBM_NO_ERROR`' ('`0`').

On error, returns '`0`' and sets `gdbm_errno` to a non-'`0`' error code.

The parameters are:

dbf The pointer returned by `gdbm_open`.

key The search key.

9 Removing records from the database.

To remove some data from the database, use the `gdbm_delete` function.

`int gdbm_delete` (*GDBM_FILE* `dbf`, *datum* `key`) [gdbm interface]

Deletes the data associated with the given *key*, if it exists in the database *dbf*. The file on disk is updated to reflect the structure of the new database before returning from this function.

The parameters are:

dbf The pointer returned by `gdbm_open`.

datum key
The search key.

The function returns '`-1`' if the item is not present or the requester is a reader. The return of '`0`' marks a successful delete.

10 Sequential access to records.

The next two functions allow for accessing all items in the database. This access is not `key` sequential, but it is guaranteed to visit every `key` in the database once. The order has to do with the hash values. `gdbm_firstkey` starts the visit of all keys in the database. `gdbm_nextkey` finds and reads the next entry in the hash structure for `dbf`.

`datum gdbm_firstkey (`*GDBM_FILE* `dbf)` [gdbm interface]

Initiate sequential access to the database *dbf*. The returned value is the first key accessed in the database. If the '`dptr`' field in the returned datum is '`NULL`', inspect the `gdbm_errno` variable (see Chapter 18 [Variables], page 27). The value of `GDBM_ITEM_NOT_FOUND` means that the database contains no data. Other value means an error occurred.

Otherwise, '`dptr`' points to a memory block obtained from `malloc`, which holds the key value. The caller is responsible for freeing this memory block when no longer needed.

`datum gdbm_nextkey (`*GDBM_FILE* `dbf`, *datum* `prev)` [gdbm interface]

This function continues the iteration over the keys in *dbf*, initiated by `gdbm_firstkey`. The parameter *prev* holds the value returned from a previous call to `gdbm_nextkey` or `gdbm_firstkey`.

The function returns next key from the database. If the '`dptr`' field in the returned datum is '`NULL`' inspect the `gdbm_errno` variable (see Chapter 18 [Variables], page 27). The value of `GDBM_ITEM_NOT_FOUND` means that all keys in the database has been visited. Any other value means an error occurred.

Otherwise, '`dptr`' points to a memory block obtained from `malloc`, which holds the key value. The caller is responsible for freeing this memory block when no longer needed.

These functions were intended to visit the database in read-only algorithms, for instance, to validate the database or similar operations. The usual algorithm for sequential access is:

```
key = gdbm_firstkey (dbf);
while (key.dptr)
  {
     datum nextkey;

     /* do something with the key */
     ...

     /* Obtain the next key */
     nextkey = gdbm_nextkey (dbf, key);
     /* Reclaim the memory used by the key */
     free (key.dptr);
     /* Use nextkey in the next iteration. */
     key = nextkey;
  }
```

Care should be taken when the `gdbm_delete` function is used in such a loop. File visiting is based on a *hash table*. The `gdbm_delete` function re-arranges the hash table to make sure that any collisions in the table do not leave some item *un-findable*. The original key order is *not* guaranteed to remain unchanged in all instances. So it is possible that some key will not be visited if a loop like the following is executed:

```
key = gdbm_firstkey (dbf);
while (key.dptr)
  {
     datum nextkey;
     if (some condition)
       {
          gdbm_delete (dbf, key);
       }
      nextkey = gdbm_nextkey (dbf, key);
      free (key.dptr);
      key = nextkey;
   }
```

11 Database reorganization.

The following function should be used very seldom.

`int gdbm_reorganize` (*GDBM_FILE dbf*) [gdbm interface]

Reorganizes the database.

The parameter is:

dbf The pointer returned by `gdbm_open`.

If you have had a lot of deletions and would like to shrink the space used by the `gdbm` file, this function will reorganize the database. This results, in particular, in shortening the length of a `gdbm` file by removing the space occupied by deleted records.

This reorganization requires creating a new file and inserting all the elements in the old file *dbf* into the new file. The new file is then renamed to the same name as the old file and *dbf* is updated to contain all the correct information about the new file. If an error is detected, the return value is negative. The value zero is returned after a successful reorganization.

12 Database Synchronization

Unless your database was opened with the '`GDBM_SYNC`' flag, `gdbm` does not wait for writes to be flushed to the disk before continuing. This allows for faster writing of databases at the risk of having a corrupted database if the application terminates in an abnormal fashion. The following function allows the programmer to make sure the disk version of the database has been completely updated with all changes to the current time.

`void gdbm_sync` (*GDBM_FILE dbf*) [gdbm interface]

Synchronizes the changes in *dbf* with its disk file. The parameter is a pointer returned by `gdbm_open`.

This function would usually be called after a complete set of changes have been made to the database and before some long waiting time. The `gdbm_close` function automatically calls the equivalent of `gdbm_sync` so no call is needed if the database is to be closed immediately after the set of changes have been made.

13 Export and Import

`Gdbm` databases can be converted into so-called *flat format* files. Such files cannot be used for searching, their sole purpose is to keep the data from the database for restoring it when the need arrives. There are two flat file formats, which differ in the way they represent the data and in the amount of meta-information stored. Both formats can be used, for example, to migrate between the different versions of `gdbm` databases. Generally speaking, flat files are safe to send over the network, and can be used to recreate the database on another machine. The recreated database is guaranteed to be a byte-to-byte equivalent of the database from which the flat file was created. This does not necessarily mean, however, that this file can be used in the same way as the original one. For example, if the original database contained non-ASCII data (e.g. C structures, integers etc.), the recreated database can be of any use only if the target machine has the same integer size and byte ordering as the source one and if its C compiler uses the same packing conventions as the one which generated C which populated the original database. In general, such binary databases are not portable between machines, unless you follow some stringent rules on what data is written to them and how it is interpreted.

The GDBM version 1.14 supports two flat file formats. The *binary* flat file format was first implemented in GDBM version 1.9.1. This format stores only key/data pairs, it does not keep information about the database file itself. As its name implies, files in this format are binary files.

The *ascii* flat file format encodes all data in base64 and stores not only key/data pairs, but also the original database file metadata, such as file name, mode and ownership. Files in this format can be sent without additional encapsulation over transmission channels that normally allow only ASCII data, such as, e.g. SMTP. Due to additional metadata they allow for restoring an exact copy of the database, including file ownership and privileges, which is especially important if the database in question contained some security-related data.

We call a process of creating a flat file from a database *exporting* or *dumping* this database. The reverse process, creating the database from a flat file is called *importing* or *loading* the database.

`int gdbm_dump` (*GDBM_FILE* ***dbf***, *const char* ****filename***, *int* ***format***, *int* ***open_flags***, *int* ***mode***) [gdbm interface]

Dumps the database file to the named file in requested format. Arguments are:

dbf A pointer to the source database, returned by a prior call to `gdbm_open`.

filename Name of the dump file.

format Output file format. Allowed values are: '`GDBM_DUMP_FMT_BINARY`' to create a binary dump and '`GDBM_DUMP_FMT_ASCII`' to create an ASCII dump file.

open_flags How to create the output file. If *flag* is '`GDBM_WRCREAT`' the file will be created if it does not exist. If it does exist, the `gdbm_dump` will fail.

If *flag* is '`GDBM_NEWDB`', the function will create a new output file, replacing it if it already exists.

mode The permissions to use when creating the output file. See Section "open a file" in *open(2) man page*, for a detailed discussion.

`int gdbm_load` (*GDBM_FILE* ***pdbf***, *const char* ***filename***, *int* ***flag***, *int* ***meta_mask***, *unsigned long* ***errline***) [gdbm interface]

Loads data from the dump file *filename* into the database pointed to by *pdbf*. The latter can point to '`NULL`', in which case the function will try to create a new database. If it succeeds, the function will return, in the memory location pointed to by *pdbf*, a pointer to the newly created database. If the dump file carries no information about the original database file name, the function will set `gdbm_errno` to '`GDBM_NO_DBNAME`' and return '`-1`', indicating failure.

The *flag* has the same meaning as the *flag* argument to the `gdbm_store` function (see Chapter 7 [Store], page 8).

The *meta_mask* argument can be used to disable restoring certain bits of file's metadata from the information in the input dump file. It is a binary OR of zero or more of the following:

GDBM_META_MASK_MODE
: Do not restore file mode.

GDBM_META_MASK_OWNER
: Do not restore file owner.

The function returns 0 upon successful completion or -1 on fatal errors and 1 on mild (non-fatal) errors.

If a fatal error occurs, `gdbm_errno` will be set to one of the following values:

GDBM_FILE_OPEN_ERROR
: Input file (*filename*) cannot be opened. The `errno` variable can be used to get more detail about the failure.

GDBM_MALLOC_ERROR
: Not enough memory to load data.

GDBM_FILE_READ_ERROR
: Reading from *filename* failed. The `errno` variable can be used to get more detail about the failure.

GDBM_ILLEGAL_DATA
: Input contained some illegal data.

GDBM_ITEM_NOT_FOUND
: This error can occur only when the input file is in ASCII format. It indicates that the data part of the record about to be read lacked length specification. Application developers are advised to treat this error equally as '`GDBM_ILLEGAL_DATA`'.

Mild errors mean that the function was able to successfully load and restore the data, but was unable to change database file metadata afterward. The table below lists possible values for `gdbm_errno` in this case. To get more detail, inspect the system `errno` variable.

GDBM_ERR_FILE_OWNER
: The function was unable to restore database file owner.

GDBM_ERR_FILE_MODE
: The function was unable to restore database file mode (permission bits).

If an error occurs while loading data from an input file in ASCII format, the number of line in which the error occurred will be stored in the location pointed to by the *errline* parameter, unless it is 'NULL'.

If the line information is not available or applicable, *errline* will be set to '0'.

`int gdbm_dump_to_file` (*GDBM_FILE* ***dbf***, *FILE* ****fp***, *int* ***format***) [gdbm interface]

This is an alternative entry point to `gdbm_dump` (which see). Arguments are:

dbf A pointer to the source database, returned by a call to `gdbm_open`.

fp File to write the data to.

format Format of the dump file. See the *format* argument to the `gdbm_dump` function.

`int gdbm_load_from_file` (*GDBM_FILE* ****pdbf***, *FILE* ****fp***, *int* ***replace***, *int* ***meta_mask***, *unsigned long* ****line***) [gdbm interface]

This is an alternative entry point to `gdbm_dump`. It writes the output to *fp* which must be a file open for writing. The rest of arguments is the same as for `gdbm_load` (excepting of course *flag*, which is not needed in this case).

`int gdbm_export` (*GDBM_FILE* ***dbf***, *const char* ****exportfile***, *int* ***flag***, *int* ***mode***) [gdbm interface]

This function is retained for compatibility with GDBM 1.10 and earlier. It dumps the database to a file in binary dump format and is entirely equivalent to

```
gdbm_dump(dbf, exportfile, GDBM_DUMP_FMT_BINARY,
          flag, mode)
```

`int gdbm_export_to_file` (*GDBM_FILE* ***dbf***, *FILE* ****fp***) [gdbm interface]

This is an alternative entry point to `gdbm_export`. This function writes to file *fp* a binary dump of the database *dbf*.

`int gdbm_import` (*GDBM_FILE* ***dbf***, *const char* ****importfile***, *int* ***flag***) [gdbm interface]

This function is retained for compatibility with GDBM 1.10 and earlier. It loads the file *importfile*, which must be a binary flat file, into the database *dbf* and is equivalent to the following construct:

```
dbf = gdbm_open (importfile, 0,
                 flag == GDBM_REPLACE ?
                   GDBM_WRCREAT : GDBM_NEWDB,
                 0600, NULL);
gdbm_load (&dbf, exportfile, 0, flag, NULL)
```

`int gdbm_import_from_file` (*GDBM_FILE* ***dbf***, *FILE* ****fp***, *int* ***flag***) [gdbm interface]

An alternative entry point to `gdbm_import`. Reads the binary dump from the file *fp* and stores the key/value pairs to *dbf*. See Chapter 7 [Store], page 8, for a description of *flag*.

This function is equivalent to:

```
dbf = gdbm_open (importfile, 0,
                         flag == GDBM_REPLACE ?
                           GDBM_WRCREAT : GDBM_NEWDB,
                         0600, NULL);
gdbm_load_from_file (dbf, fp, flag, 0, NULL);
```

14 Error handling.

The global variable `gdbm_errno` (see Chapter 18 [Variables], page 27) keeps the error code of the most recent error encountered by GDBM functions.

To convert this code to human-readable string, use the following function:

`const char * gdbm_strerror` (*gdbm_error* ***errno***) [gdbm interface]
: Converts *errno* (which is an integer value) into a human-readable descriptive text. Returns a pointer to a static string. The caller must not alter or free the returned pointer.

Detailed information about the most recent error that occurred while operating on a GDBM file is stored in the `GDBM_FILE` object itself. To retrieve it, the following functions are provided:

`gdbm_error gdbm_last_errno` (*GDBM_FILE* ***dbf***) [gdbm interface]
: Returns the code of the most recent error encountered when operating on *dbf*.

`int gdbm_last_syserr` (*GDBM_FILE* ***dbf***) [gdbm interface]
: Returns the value of the system `errno` variable associated with the most recent error.

  Notice, that not all GDBM errors have an associated system error code. The following are the ones that have:

  - GDBM_FILE_OPEN_ERROR
  - GDBM_FILE_WRITE_ERROR
  - GDBM_FILE_SEEK_ERROR
  - GDBM_FILE_READ_ERROR
  - GDBM_FILE_STAT_ERROR
  - GDBM_BACKUP_FAILED

  For other errors, `gdbm_last_syserr` will return 0.

`int gdbm_check_syserr` (*gdbm_errno* ***err***) [gdbm interface]
: Returns `1`, if system errno value should be checked to get more info on the error described by GDBM code *err*.

To get a human-readable description of the recent error for a particular database file, use the `gdbm_db_strerror` function:

`const char * gdbm_db_strerror` (*GDBM_FILE* ***dbf***) [gdbm interface]
: Returns textual description of the most recent error encountered when operating on the database *dbf*. The resulting string is often more informative than what would be returned by '`gdbm_strerror(gdbm_last_errno(dbf))`'. In particular, if there is a system error associated with the recent failure, it will be described as well.

`void gdbm_clear_error` (*GDBM_FILE* ***dbf***) [gdbm interface]
: Clears the error state for the database *dbf*. Normally, this function is called upon the entry to any GDBM function.

Certain errors (such as write error when saving stored key) can leave database file in inconistent state. When such a critical error occurs, the database file is marked as needing recovery. Subsequent calls to any GDBM functions for that database file (except `gdbm_recover`), will return immediately with GDBM error value `GDBM_NEED_RECOVERY`. Additionally, the following function can be used to check the state of the database file:

`int gdbm_needs_recovery (`*GDBM_FILE* ***dbf***`)` [gdbm interface]

Returns `1` if the database file *dbf* is in inconsistent state and needs recovery.

The only way to bring the database back to operational state is to call the `gdbm_recover` function (see Chapter 15 [Recovery], page 21).

15 Recovery

Certain errors (such as write error when saving stored key) can leave database file in *inconistent state*. When such a critical error occurs, the database file is marked as needing recovery. Subsequent calls to any GDBM functions for that database file (except `gdbm_recover`), will return immediately with GDBM error value `GDBM_NEED_RECOVERY`.

To escape from this state and bring the database back to operational state, use the following function:

`int gdbm_recover (`*GDBM_FILE* `dbf`, *gdbm_recovery* `*rcvr`, *int* `flags`) [gdbm interface]

Check the database file *dbf* and fix eventual errors. The *rcvr* argument points to a structure that has *input members*, providing additional information to alter the behavior of `gdbm_recover`, and *output members*, used to return additional statistics about the recovery process (*rcvr* can be `NULL` if no such information is needed).

Each input member has a corresponding flag bit, which must be set in the *flags* in order to instruct the function to use it.

The `gdbm_recover` type is defined as:

```
typedef struct gdbm_recovery_s
{
  /* Input members.
     These are initialized before call to gdbm_recover.
     The flags argument specifies which of them are initialized. */
  void (*errfun) (void *data, char const *fmt, ...);
  void *data;
  size_t max_failed_keys;
  size_t max_failed_buckets;
  size_t max_failures;

  /* Output members.
     The gdbm_recover function fills these before returning. */
  size_t recovered_keys;
  size_t recovered_buckets;
  size_t failed_keys;
  size_t failed_buckets;
  char *backup_name;
} gdbm_recovery;
```

The *input members* modify the behavior of `gdbm_recover`:

`void (*errfun) (`*void* `*data`, *char const* `*fmt`, *...*) [input member on `gdbm_recovery`]

If the `GDBM_RCVR_ERRFUN` flag bit is set, `errfun` points to a function that will be called upon each recoverable or non-fatal error that occurred during the recovery.

`void * data` [input member of `gdbm_recovery`]

Supplies first argument for the `errfun` invocations.

`size_t max_failed_keys` [input member of `gdbm_recovery`]
: If `GDBM_RCVR_MAX_FAILED_KEYS` is set, this member sets the limit on the number of keys that cannot be retrieved. If the number of failed keys grows bigger than `max_failed_keys`, recovery is aborted and error is returned.

`size_t max_failed_buckets` [input member of `gdbm_recovery`]
: If `GDBM_RCVR_MAX_FAILED_BUCKETS` is set, this member sets the limit on the number of buckets that cannot be retrieved or that contain bogus information. If the number of failed buckets grows bigger than `max_failed_buckets`, recovery is aborted and error is returned.

`size_t max_failures` [output member of `gdbm_recovery`]
: If `GDBM_RCVR_MAX_FAILURES` is set, this member sets the limit of failures that are tolerated during recovery. If the number of errors grows bigger than `max_failures`, recovery is aborted and error is returned.

The following members are filled on output, upon successful return from the function:

`size_t recovered_keys` [output member of `gdbm_recovery`]
: Number of recovered keys.

`size_t recovered_buckets` [output member of `gdbm_recovery`]
: Number of recovered buckets.

`size_t failed_keys` [output member of `gdbm_recovery`]
: Number of key/data pairs that cannot be retrieved.

`size_t failed_buckets` [output member of `gdbm_recovery`]
: Number of buckets that cannot be retrieved.

`char * backup_name` [output member of `gdbm_recovery`]
: Name of the file keeping the copy of the original database, in the state prior to recovery. It is filled if the *GDBM_RCVR_BACKUP* flag is set. The string is allocated using the `malloc` call. The caller is responsible for freeing that memory when no longer needed.

By default, `gdbm_recovery` first checks the database fo inconsistencies and attempts recovery only if some were found. The special flag bit `GDBM_RCVR_FORCE` instructs `gdbm_recovery` to omit this check and to force recovery unconditionally.

16 Setting options

`Gdbm` supports the ability to set certain options on an already open database.

`int gdbm_setopt (`*GDBM_FILE* `dbf`, *int* `option`, *void* *`value`, *int* `size``)` [gdbm interface]

Sets an option on the database or returns the value of an option.

The parameters are:

dbf The pointer returned by `gdbm_open`.

option The option to be set or retrieved.

value A pointer to the value to which *option* will be set or where to place the option value (depending on the option).

size The length of the data pointed to by *value*.

The valid options are:

GDBM_SETCACHESIZE
GDBM_CACHESIZE
: Set the size of the internal bucket cache. This option may only be set once on each GDBM_FILE descriptor, and is set automatically to 100 upon the first access to the database. The *value* should point to a `size_t` holding the desired cache size.

  The '`GDBM_CACHESIZE`' option is provided for compatibility with earlier versions.

GDBM_GETCACHESIZE
: Return the size of the internal bucket cache. The *value* should point to a `size_t` variable, where the size will be stored.

GDBM_GETFLAGS
: Return the flags describing the state of the database. The *value* should point to a `int` variable where to store the flags. The return is the same as the flags used when opening the database (see Chapter 4 [Open], page 4), except that it reflects the current state (which may have been altered by another calls to `gdbm_setopt`.

GDBM_FASTMODE
: Enable or disable the *fast writes mode*, i.e. writes without subsequent synchronization. The *value* should point to an integer: '`TRUE`' to enable fast mode, and '`FALSE`' to disable it.

  This option is retained for compatibility with previous versions of `gdbm`. Its effect is the reverse of `GDBM_SETSYNCMODE` (see below).

GDBM_SETSYNCMODE
GDBM_SYNCMODE
: Turn on or off file system synchronization operations. This setting defaults to off. The *value* should point to an integer: '`TRUE`' to turn synchronization on, and '`FALSE`' to turn it off.

Note, that this option is a reverse of `GDBM_FASTMODE`, i.e. calling `GDBM_SETSYNCMODE` with '`TRUE`' has the same effect as calling `GDBM_FASTMODE` with '`FALSE`'.

The '`GDBM_SYNCMODE`' option is provided for compatibility with earlier versions.

GDBM_GETSYNCMODE
: Return the current synchronization status. The *value* should point to an `int` where the status will be stored.

GDBM_SETCENTFREE
GDBM_CENTFREE
: *NOTICE: This feature is still under study.*

Set central free block pool to either on or off. The default is off, which is how previous versions of `gdbm` handled free blocks. If set, this option causes all subsequent free blocks to be placed in the *global* pool, allowing (in theory) more file space to be reused more quickly. The *value* should point to an integer: '`TRUE`' to turn central block pool on, and '`FALSE`' to turn it off.

The '`GDBM_CENTFREE`' option is provided for compatibility with earlier versions.

GDBM_SETCOALESCEBLKS
GDBM_COALESCEBLKS
: *NOTICE: This feature is still under study.*

Set free block merging to either on or off. The default is off, which is how previous versions of `gdbm` handled free blocks. If set, this option causes adjacent free blocks to be merged. This can become a CPU expensive process with time, though, especially if used in conjunction with GDBM_CENTFREE. The *value* should point to an integer: '`TRUE`' to turn free block merging on, and '`FALSE`' to turn it off.

GDBM_GETCOALESCEBLKS
: Return the current status of free block merging. The *value* should point to an `int` where the status will be stored.

GDBM_SETMAXMAPSIZE
: Sets maximum size of a memory mapped region. The *value* should point to a value of type `size_t`, `unsigned long` or `unsigned`. The actual value is rounded to the nearest page boundary (the page size is obtained from `sysconf(_SC_PAGESIZE)`).

GDBM_GETMAXMAPSIZE
: Return the maximum size of a memory mapped region. The *value* should point to a value of type `size_t` where to return the data.

GDBM_SETMMAP
: Enable or disable memory mapping mode. The *value* should point to an integer: '`TRUE`' to enable memory mapping or '`FALSE`' to disable it.

GDBM_GETMMAP
: Check whether memory mapping is enabled. The *value* should point to an integer where to return the status.

GDBM_GETDBNAME
: Return the name of the database disk file. The *value* should point to a variable of type `char**`. A pointer to the newly allocated copy of the file name will be placed there. The caller is responsible for freeing this memory when no longer needed. For example:

```
char *name;

if (gdbm_setopt (dbf, GDBM_GETDBNAME, &name, sizeof (name)))
  {
     fprintf (stderr, "gdbm_setopt failed: %s\n",
              gdbm_strerror (gdbm_errno));
  }
else
  {
    printf ("database name: %s\n", name);
    free (name);
  }
```

GDBM_GETBLOCKSIZE
: Return the block size in bytes. The *value* should point to `int`.

The return value will be '`-1`' upon failure, or '`0`' upon success. The global variable `gdbm_errno` will be set upon failure.

For instance, to set a database to use a cache of 10, after opening it with `gdbm_open`, but prior to accessing it in any way, the following code could be used:

```
int value = 10;
ret = gdbm_setopt (dbf, GDBM_CACHESIZE, &value, sizeof (int));
```

17 File Locking.

With locking disabled (if `gdbm_open` was called with '`GDBM_NOLOCK`'), the user may want to perform their own file locking on the database file in order to prevent multiple writers operating on the same file simultaneously.

In order to support this, the `gdbm_fdesc` routine is provided.

`int gdbm_fdesc` (*GDBM_FILE* `dbf`) [gdbm interface]

Returns the file descriptor of the database *dbf*. This value can be used as an argument to `flock`, `lockf` or similar calls.

18 Useful global variables.

The following global variables and constants are available:

`gdbm_error gdbm_errno` [Variable]
: This variable contains error code from the last failed `gdbm` call. See Chapter 19 [Error codes], page 29, for a list of available error codes and their descriptions.

  Use `gdbm_strerror` (see Chapter 14 [Errors], page 19) to convert it to a descriptive text.

`const char * gdbm_errlist[]` [Variable]
: This variable is an array of error descriptions, which is used by `gdbm_strerror` to convert error codes to human-readable text (see Chapter 14 [Errors], page 19). You can access it directly, if you wish so. It contains `_GDBM_MAX_ERRNO + 1` elements and can be directly indexed by the error code to obtain a corresponding descriptive text.

`int const gdbm_syserr[]` [Variable]
: Array of boolean values indicating, for each GDBM error code, whether the value of `errno`(3) variable is meaningful for this error code. See [gdbm_check_syserr], page 19.

`_GDBM_MIN_ERRNO` [Constant]
: The minimum error code used by `gdbm`.

`_GDBM_MAX_ERRNO` [Constant]
: The maximum error code used by `gdbm`.

`const char * gdbm_version` [Variable]
: A string containing the version information.

`int const gdbm_version_number[3]` [Variable]
: This variable contains the `gdbm` version numbers:

Index	**Meaning**
0	Major number
1	Minor number
2	Patchlevel number

  Additionally, the following constants are defined in the `gdbm.h` file:

  GDBM_VERSION_MAJOR
  : Major number.

  GDBM_VERSION_MINOR
  : Minor number.

  GDBM_VERSION_PATCH
  : Patchlevel number.

  These can be used to verify whether the header file matches the library.

To compare two split-out version numbers, use the following function:

`int gdbm_version_cmp` (*int const* `a`[*3*], *int const* `b`[*3*]) [gdbm interface]

Compare two version numbers. Return '`-1`' if *a* is less than *b*, '`1`' if *a* is greater than *b* and '`0`' if they are equal.

Comparison is done from left to right, so that:

```
a = { 1, 8, 3 };
b = { 1, 8, 3 };
gdbm_version_cmp (a, b) ⇒ 0

a = { 1, 8, 3 };
b = { 1, 8, 2 };
gdbm_version_cmp (a, b) ⇒ 1

a = { 1, 8, 3 };
b = { 1, 9. 0 };
gdbm_version_cmp (a, b) ⇒ -1
```

19 Error codes

This chapter summarizes error codes which can be set by the functions in `gdbm` library.

GDBM_NO_ERROR
: No error occurred.

GDBM_MALLOC_ERROR
: Memory allocation failed. Not enough memory.

GDBM_BLOCK_SIZE_ERROR
: This error is set by the `gdbm_open` function (see Chapter 4 [Open], page 4), if the value of its *block_size* argument is incorrect and the '`GDBM_BSEXACT`' flag is set.

GDBM_FILE_OPEN_ERROR
: The library was not able to open a disk file. This can be set by `gdbm_open` (see Chapter 4 [Open], page 4), `gdbm_export` and `gdbm_import` functions (see Chapter 13 [Flat files], page 15).

  Inspect the value of the system `errno` variable to get more detailed diagnostics.

GDBM_FILE_WRITE_ERROR
: Writing to a disk file failed. This can be set by `gdbm_open` (see Chapter 4 [Open], page 4), `gdbm_export` and `gdbm_import` functions.

  Inspect the value of the system `errno` variable to get more detailed diagnostics.

GDBM_FILE_SEEK_ERROR
: Positioning in a disk file failed. This can be set by `gdbm_open` (see Chapter 4 [Open], page 4) function.

  Inspect the value of the system `errno` variable to get a more detailed diagnostics.

GDBM_FILE_READ_ERROR
: Reading from a disk file failed. This can be set by `gdbm_open` (see Chapter 4 [Open], page 4), `gdbm_export` and `gdbm_import` functions.

  Inspect the value of the system `errno` variable to get a more detailed diagnostics.

GDBM_BAD_MAGIC_NUMBER
: The file given as argument to `gdbm_open` function is not a valid `gdbm` file: it has a wrong magic number.

GDBM_EMPTY_DATABASE
: The file given as argument to `gdbm_open` function is not a valid `gdbm` file: it has zero length.

GDBM_CANT_BE_READER
: This error code is set by the `gdbm_open` function if it is not able to lock file when called in '`GDBM_READER`' mode (see Chapter 4 [Open], page 4).

GDBM_CANT_BE_WRITER
: This error code is set by the `gdbm_open` function if it is not able to lock file when called in writer mode (see Chapter 4 [Open], page 4).

GDBM_READER_CANT_DELETE
: Set by the `gdbm_delete` (see Chapter 9 [Delete], page 10) if it attempted to operate on a database that is open in read-only mode (see Chapter 4 [Open], page 4).

GDBM_READER_CANT_STORE
: Set by the `gdbm_store` (see Chapter 7 [Store], page 8) if it attempted to operate on a database that is open in read-only mode (see Chapter 4 [Open], page 4).

GDBM_READER_CANT_REORGANIZE
: Set by the `gdbm_reorganize` (see Chapter 11 [Reorganization], page 13) if it attempted to operate on a database that is open in read-only mode (see Chapter 4 [Open], page 4).

GDBM_ITEM_NOT_FOUND
: Requested item was not found. This error is set by `gdbm_delete` (see Chapter 9 [Delete], page 10) and `gdbm_fetch` (see Chapter 8 [Fetch], page 9) when the requested *key* value is not found in the database.

GDBM_REORGANIZE_FAILED
: The `gdbm_reorganize` function is not able to create a temporary database. See Chapter 11 [Reorganization], page 13.

GDBM_CANNOT_REPLACE
: Cannot replace existing item. This error is set by the `gdbm_store` if the requested *key* value is found in the database and the *flag* parameter is not '`GDBM_REPLACE`'. See Chapter 7 [Store], page 8, for a detailed discussion.

GDBM_ILLEGAL_DATA
: Either *key* or *content* parameter was wrong in a call to to `gdbm_store` (see Chapter 7 [Store], page 8).

GDBM_OPT_ALREADY_SET
: Requested option can be set only once and was already set. This error is returned by the `gdbm_setopt` function. See Chapter 16 [Options], page 23.

GDBM_OPT_ILLEGAL
: The *option* argument is not valid or the *value* argument points to an invalid value in a call to `gdbm_setopt` function. See Chapter 16 [Options], page 23.

GDBM_BYTE_SWAPPED
: The `gdbm_open` function (see Chapter 4 [Open], page 4) attempts to open a database which is created on a machine with different byte ordering.

GDBM_BAD_FILE_OFFSET
: The `gdbm_open` function (see Chapter 4 [Open], page 4) sets this error code if the file it tries to open has a wrong magic number.

GDBM_BAD_OPEN_FLAGS
: Set by the `gdbm_export` function if supplied an invalid *flags* argument. See Chapter 13 [Flat files], page 15.

GDBM_FILE_STAT_ERROR
: Getting information about a disk file failed. The system `errno` will give more details about the error.

This error can be set by the following functions: `gdbm_open`, `gdbm_reorganize`.

GDBM_FILE_EOF
: End of file was encountered where more data was expected to be present. This error can occur when fetching data from the database and usually means that the database is truncated or otherwise corrupted.

  This error can be set by any GDBM function that does I/O. Some of these functions are: `gdbm_delete`, `gdbm_exists`, `gdbm_fetch`, `gdbm_export`, `gdbm_import`, `gdbm_reorganize`, `gdbm_firstkey`, `gdbm_nextkey`, `gdbm_store`.

GDBM_NO_DBNAME
: Output database name is not specified. This error code is set by `gdbm_load` (see [gdbm_load], page 16) if the first argument points to '`NULL`' and the input file does not specify the database name.

GDBM_ERR_FILE_OWNER
: This error code is set by `gdbm_load` if it is unable to restore database file owner. It is a mild error condition, meaning that the data have been restored successfully, only changing the target file owner failed. Inspect the system `errno` variable to get a more detailed diagnostics.

GDBM_ERR_FILE_MODE
: This error code is set by `gdbm_load` if it is unable to restore database file mode. It is a mild error condition, meaning that the data have been restored successfully, only changing the target file owner failed. Inspect the system `errno` variable to get a more detailed diagnostics.

GDBM_NEED_RECOVERY
: Database is in inconsistent state and needs recovery. Call `gdbm_recover` if you get this error. See Chapter 15 [Recovery], page 21, for a detailed description of recovery functions.

GDBM_BACKUP_FAILED
: The GDBM engine is unable to create backup copy of the file.

GDBM_DIR_OVERFLOW
: Bucket directory would overflow the size limit during an attempt to split hash bucket. This error can occur while storing a new key.

20 Compatibility with standard dbm and ndbm.

Gdbm includes a compatibility layer, which provides traditional 'ndbm' and older 'dbm' functions. The layer is compiled and installed if the `--enable-libgdbm-compat` option is used when configuring the package.

The compatibility layer consists of two header files: `ndbm.h` and `dbm.h` and the `libgdbm_compat` library.

Older programs using `ndbm` or `dbm` interfaces can use `libgdbm_compat` without any changes. To link a program with the compatibility library, add the following two options to the `cc` invocation: `-lgdbm -lgdbm_compat`. The `-L` option may also be required, depending on where `gdbm` is installed, e.g.:

```
cc ... -lgdbm -lgdbm_compat
```

Databases created and manipulated by the compatibility interfaces consist of two different files: *`file`*`.dir` and *`file`*`.pag`. This is required by the POSIX specification and corresponds to the traditional usage. Note, however, that despite the similarity of the naming convention, actual data stored in these files has not the same format as in the databases created by other `dbm` or `ndbm` libraries. In other words, you cannot access a standard UNIX `dbm` file with GNU `dbm`!

GNU `dbm` files are not `sparse`. You can copy them with the usual `cp` command and they will not expand in the copying process.

20.1 NDBM interface functions.

The functions below implement the POSIX 'ndbm' interface:

`DBM * dbm_open` (*char *`file`, int `flags`, int `mode`*) [ndbm]

Opens a database. The *file* argument is the full name of the database file to be opened. The function opens two files: *`file`*`.pag` and *`file`*`.dir`. The *flags* and *mode* arguments have the same meaning as the second and third arguments of `open` (see Section "open a file" in *open(2) man page*), except that a database opened for write-only access opens the files for read and write access and the behavior of the `O_APPEND` flag is unspecified.

The function returns a pointer to the `DBM` structure describing the database. This pointer is used to refer to this database in all operations described below.

Any error detected will cause a return value of 'NULL' and an appropriate value will be stored in `gdbm_errno` (see Chapter 18 [Variables], page 27).

`void dbm_close` (*DBM *`dbf`*) [ndbm]

Closes the database. The *dbf* argument must be a pointer returned by an earlier call to `dbm_open`.

`datum dbm_fetch` (*DBM *`dbf`, datum `key`*) [ndbm]

Reads a record from the database with the matching key. The *key* argument supplies the key that is being looked for.

If no matching record is found, the `dptr` member of the returned datum is 'NULL'. Otherwise, the `dptr` member of the returned datum points to the memory managed by the compatibility library. The application should never free it.

`int dbm_store` (*DBM *dbf*, *datum key*, *datum content*, *int mode*) [ndbm]

Writes a key/value pair to the database. The argument *dbf* is a pointer to the `DBM` structure returned from a call to `dbm_open`. The *key* and *content* provide the values for the record key and content. The *mode* argument controls the behavior of `dbm_store` in case a matching record already exists in the database. It can have one of the following two values:

`DBM_REPLACE`
: Replace existing record with the new one.

`DBM_INSERT`
: The existing record is left unchanged, and the function returns '`1`'.

If no matching record exists in the database, new record will be inserted no matter what the value of the *mode* is.

`int dbm_delete` (*DBM *dbf*, *datum key*) [ndbm]

Deletes the record with the matching key from the database. If the function succeeds, '`0`' is returned. Otherwise, if no matching record is found or if an error occurs, '`-1`' is returned.

`datum dbm_firstkey` (*DBM *dbf*) [ndbm]

Initializes iteration over the keys from the database and returns the first key. Note, that the word '`first`' does not imply any specific ordering of the keys.

If there are no records in the database, the `dptr` member of the returned datum is '`NULL`'. Otherwise, the `dptr` member of the returned datum points to the memory managed by the compatibility library. The application should never free it.

`datum dbm_nextkey` (*DBM *dbf*) [ndbm]

Continues the iteration started by `dbm_firstkey`. Returns the next key in the database. If the iteration covered all keys in the database, the `dptr` member of the returned datum is '`NULL`'. Otherwise, the `dptr` member of the returned datum points to the memory managed by the compatibility library. The application should never free it.

The usual way of iterating over all the records in the database is:

```
for (key = dbm_firstkey (dbf);
     key.ptr;
     key = dbm_nextkey (dbf))
  {
    /* do something with the key */
  }
```

The loop above should not try to delete any records from the database, otherwise the iteration is not guaranteed to cover all the keys. See Chapter 10 [Sequential], page 11, for a detailed discussion of this.

`int dbm_error` (*DBM *dbf*) [ndbm]

Returns the error condition of the database: '`0`' if no errors occurred so far while manipulating the database, and a non-zero value otherwise.

`void dbm_clearerr` (*DBM *dbf*) [ndbm]
: Clears the error condition of the database.

`int dbm_dirfno` (*DBM *dbf*) [ndbm]
: Returns the file descriptor of the '`dir`' file of the database. It is guaranteed to be different from the descriptor returned by the `dbm_pagfno` function (see below).

  The application can lock this descriptor to serialize accesses to the database.

`int dbm_pagfno` (*DBM *dbf*) [ndbm]
: Returns the file descriptor of the '`pag`' file of the database. See also `dbm_dirfno`.

`int dbm_rdonly` (*DBM *dbf*) [ndbm]
: Returns '`1`' if the database *dbf* is open in a read-only mode and '`0`' otherwise.

20.2 DBM interface functions.

The functions below are provided for compatibility with the old UNIX '`DBM`' interface. Only one database at a time can be manipulated using them.

`int dbminit` (*char *file*) [dbm]
: Opens a database. The *file* argument is the full name of the database file to be opened. The function opens two files: *`file`*`.pag` and *`file`*`.dir`. If any of them does not exist, the function fails. It never attempts to create the files.

  The database is opened in the read-write mode, if its disk permissions permit.

  The application must ensure that the functions described below in this section are called only after a successful call to `dbminit`.

`int dbmclose` (*void*) [dbm]
: Closes the database opened by an earlier call to `dbminit`.

`datum fetch` (*datum key*) [dbm]
: Reads a record from the database with the matching key. The *key* argument supplies the key that is being looked for.

  If no matching record is found, the `dptr` member of the returned datum is '`NULL`'. Otherwise, the `dptr` member of the returned datum points to the memory managed by the compatibility library. The application should never free it.

`int store` (*datum key, datum content*) [dbm]
: Stores the key/value pair in the database. If a record with the matching key already exists, its content will be replaced with the new one.

  Returns '`0`' on success and '`-1`' on error.

`int delete` (*datum key*) [dbm]
: Deletes a record with the matching key.

  If the function succeeds, '`0`' is returned. Otherwise, if no matching record is found or if an error occurs, '`-1`' is returned.

`datum firstkey` (*void*) [dbm]

Initializes iteration over the keys from the database and returns the first key. Note, that the word '`first`' does not imply any specific ordering of the keys.

If there are no records in the database, the `dptr` member of the returned datum is '`NULL`'. Otherwise, the `dptr` member of the returned datum points to the memory managed by the compatibility library. The application should never free it.

`datum nextkey` (*datum key*) [dbm]

Continues the iteration started by a call to `firstkey`. Returns the next key in the database. If the iteration covered all keys in the database, the `dptr` member of the returned datum is '`NULL`'. Otherwise, the `dptr` member of the returned datum points to the memory managed by the compatibility library. The application should never free it.

21 Examine and modify a GDBM database.

The `gdbmtool` utility allows you to view and modify an existing GDBM database or to create a new one.

When invoked without arguments, it tries to open a database file called `junk.gdbm`, located in the current working directory. You can change this default by supplying the name of the database as argument to the program, e.g.:

```
$ gdbmtool file.db
```

The database will be opened in read-write mode, unless the `-r` (`--read-only`) option is specified, in which case it will be opened only for reading.

If the database does not exist, `gdbmtool` will create it. There is a special option `-n` (`--newdb`, which instructs the utility to create a new database. If it is used and if the database already exists, it will be deleted, so use it sparingly.

21.1 gdbmtool invocation

The following table summarizes all `gdbmtool` command line options:

`-b` *size*
`--block-size=`*size*
: Set block size.

`-c` *size*
`--cache-size=`*size*
: Set cache size.

`-f` *file*

`--file` *file*
: Read commands from *file*, instead of the standard input.

`-h`
`--help`
: Print a concise help summary.

`-N`
`--norc`
: Don't read startup files (see Section 21.2.4 [startup files], page 45).

`-n`
`--newdb`
: Create the database.

`-l`
`--no-lock`
: Disable file locking.

`-m`
`--no-mmap`
: Disable mmap.

`-q`
`--quiet`
: Don't print the usual welcome banner at startup. This is the same as setting the variable '`quiet`' in the startup file. See [quiet], page 39.

`-r`
`--read-only`
: Open the database in read-only mode.

`-s`
`--synchronize`
: Synchronize to the disk after each write.

`-V`
`--version`
: Print program version and licensing information and exit.

`--usage`
: Print a terse invocation syntax summary along with a list of available command line options.

21.2 gdbmtool interactive mode

After successful startup, `gdbmtool` starts a loop, in which it reads commands from the standard input, executes them and prints results on the standard output. If the standard input is attached to a console, `gdbmtool` runs in interactive mode, which is indicated by its *prompt*:

```
gdbmtool> _
```

The utility finishes when it reads the '`quit`' command (see below) or detects end-of-file on its standard input, whichever occurs first.

A `gdbmtool` command consists of a *command verb*, optionally followed by *arguments*, separated by any amount of white space. A command verb can be entered either in full or in an abbreviated form, as long as that abbreviation does not match any other verb. For example, '`co`' can be used instead of '`count`' and '`ca`' instead of '`cache`'.

Any sequence of non-whitespace characters appearing after the command verb forms an argument. If the argument contains whitespace or unprintable characters it must be enclosed in double quotes. Within double quotes the usual *escape sequences* are understood, as shown in the table below:

Sequence	Replaced with
\a	Audible bell character (ASCII 7)
\b	Backspace character (ASCII 8)
\f	Form-feed character (ASCII 12)
\n	Newline character (ASCII 10)
\r	Carriage return character (ASCII 13)
\t	Horizontal tabulation character (ASCII 9)
\v	Vertical tabulation character (ASCII 11)
\\	Single slash
\"	Double quote

Table 21.1: Backslash escapes

In addition, a backslash immediately followed by the end-of-line character effectively removes that character, allowing to split long arguments over several input lines.

Command parameters may be optional or mandatory. If the number of actual arguments is less than the number of mandatory parameters, `gdbmtool` will prompt you to supply

missing arguments. For example, the '`store`' command takes two mandatory parameters, so if you invoked it with no arguments, you would be prompted twice to supply the necessary data, as shown in example below:

```
gdbmtool> store
key? three
data? 3
```

However, such prompting is possible only in interactive mode. In non-interactive mode (e.g. when running a script), all arguments must be supplied with each command, otherwise `gdbmtool` will report an error and exit immediately.

If the package is compiled with GNU Readline, the input line can be edited (see Section "Command Line Editing" in *GNU Readline Library*).

21.2.1 Shell Variables

A number of `gdbmtool` parameters is kept in its internal variables.

`bool confirm` [gdbmtool variable]

Whether to ask for confirmation before certain destructive operations, such as truncating the existing database.

Default is '`true`'.

`string ps1` [gdbmtool variable]

Primary prompt string. Its value can contain *conversion specifiers*, consisting of the '`%`' character followed by another character. These specifiers are expanded in the resulting prompt as follows:

Sequence	**Expansion**
%f	name of the current database file
%p	program invocation name
%P	package name ('`GDBM`')
%v	program version
%_	single space character
%%	%

The default value is '`%p>%_`', i.e. the program name, followed by a "greater than" sign, followed by a single space.

`string ps2` [gdbmtool variable]

Secondary prompt. See '`ps1`' for a description of its value. This prompt is displayed before reading the second and subsequent lines of a multi-line command.

The default value is '`%_>%_`'.

`string delim1` [gdbmtool variable]

A string used to delimit fields of a structured datum on output (see Section 21.2.3 [definitions], page 43).

Default is '`,`' (a comma). This variable cannot be unset.

`string delim2` [gdbmtool variable]

A string used to delimit array items when printing a structured datum (see Section 21.2.3 [definitions], page 43).

Default is '`,`' (a comma). This variable cannot be unset.

`string pager` [gdbmtool variable]

The name and command line of the pager program to pipe output to. This program is used in interactive mode when the estimated number of output lines is greater then the number of lines on your screen.

The default value is inherited from the environment variable `PAGER`. Unsetting this variable disables paging.

`bool quiet` [gdbmtool variable]

Whether to display a welcome banner at startup. This variable should be set in a startup script file (see Section 21.2.4 [startup files], page 45). See [-q option], page 36.

The following variables control how the database is opened:

`numeric blocksize` [gdbmtool variable]

Sets the block size. See Chapter 4 [Open], page 4. Unset by default.

`numeric cachesize` [gdbmtool variable]

Sets the cache size. See Chapter 16 [Options], page 23. By default this variable is not set.

`string open` [gdbmtool variable]

Open mode. The following values are allowed:

newdb
: Truncate the database if it exists or create a new one. Open it in read-write mode.

  Technically, this sets the '`GDBM_NEWDB`' flag in call to '`gdbm_open`'. See Chapter 4 [Open], page 4.

wrcreat
rw
: Open the database in read-write mode. Create it if it does not exist. This is the default.

  Technically speaking, it sets the '`GDBM_WRCREAT`' flag in call to `gdbm_open`. See Chapter 4 [Open], page 4.

reader
readonly
: Open the database in read-only mode. Signal an error if it does not exist.

  This sets the '`GDBM_READER`' flag (see Chapter 4 [Open], page 4).

Attempting to set any other value or to unset this variable produces an error.

`number filemode` [gdbmtool variable]

File mode (in octal) for creating new database files and database dumps.

`bool lock` [gdbmtool variable]

Lock the database. This is the default.

Setting this variable to false or unsetting it results in passing '`GDBM_NOLOCK`' flag to `gdbm_open` (see Chapter 4 [Open], page 4).

`bool mmap` [gdbmtool variable]

Use memory mapping. This is the default.

Setting this variable to false or unsetting it results in passing '`GDBM_NOMMAP`' flag to `gdbm_open` (see Chapter 4 [Open], page 4).

`bool sync` [gdbmtool variable]

Flush all database writes on disk immediately. Default is false. See Chapter 4 [Open], page 4.

The following commands are used to list or modify the variables:

`set` [*assignments*] [command verb]

When used without arguments, lists all variables and their values. Unset variables are shown after a comment sign ('`#`'). For string and numeric variables, values are shown after an equals sign. For boolean variables, only the variable name is displayed if the variable is '`true`'. If it is '`false`', its name is prefixed with '`no`'.

For example:

```
ps1="%p>%_"
ps2="%_>%_"
delim1=","
delim2=","
confirm
# cachesize is unset
# blocksize is unset
open="wrcreat"
lock
mmap
nosync
pager="less"
# quiet is unset
```

If used with arguments, the `set` command alters the specified variables. In this case, arguments are variable assignments in the form '*name*`=`*value*'. For boolean variables, the *value* is interpreted as follows: if it is numeric, '`0`' stands for '`false`', any non-zero value stands for '`true`'. Otherwise, the values '`on`', '`true`', and '`yes`' denote '`true`', and '`off`', '`false`', '`no`' stand for '`false`'. Alternatively, only the name of a boolean variable can be supplied to set it to '`true`', and its name prefixed with '`no`' can be used to set it to false. For example, the following command sets the '`delim2`' variable to '`;`' and the '`confirm`' variable to '`false`':

```
set delim2=";" noconfirm
```

`unset` *variables* [command verb]

Unsets the listed variables. The effect of unsetting depends on the variable. Unless explicitly described in the discussion of the variables above, unsetting a boolean variable is equivalent to setting it to '`false`'. Unsetting a string variable is equivalent to assigning it an empty string.

21.2.2 Gdbmtool Commands

`avail` [command verb]
: Print the *avail list*.

`bucket` *num* [command verb]
: Print the bucket number *num* and set it as the current one.

`cache` [command verb]
: Print the bucket cache.

`close` [command verb]
: Close the currently open database.

`count` [command verb]
: Print the number of entries in the database.

`current` [command verb]
: Print the current bucket.

`delete` *key* [command verb]
: Delete record with the given *key*

`dir` [command verb]
: Print hash directory.

`export` *file-name* [*truncate*] [*binary*|*ascii*] [command verb]
: Export the database to the flat file *file-name*. See Chapter 13 [Flat files], page 15, for a description of the flat file format and its purposes. This command will not overwrite an existing file, unless the '`truncate`' parameter is also given. Another optional argument determines the type of the dump (see Chapter 13 [Flat files], page 15). By default, ASCII dump is created.

  The global variable `filemode` specifies the permissions to use for the created output file.

  See also Chapter 24 [gdbmexport], page 48.

`fetch` *key* [command verb]
: Fetch and display the record with the given *key*.

`first` [command verb]
: Fetch and display the first record in the database. Subsequent records can be fetched using the `next` command (see below). See Chapter 10 [Sequential], page 11, for more information on sequential access.

`hash` *key* [command verb]
: Compute and display the hash value for the given *key*.

`header` [command verb]
: Print file header.

`help` [command verb]
`?` [command verb]

Print a concise command summary, showing each command verb with its parameters and a short description of what it does. Optional arguments are enclosed in square brackets.

`import` *`file-name`* [*replace*] [*nometa*] [command verb]

Import data from a flat dump file *file-name* (see Chapter 13 [Flat files], page 15). If the word '`replace`' is given as an argument, any records with the same keys as the already existing ones will replace them. The word '`nometa`' turns off restoring meta-information from the dump file.

`history` [command verb]
`history` *`count`* [command verb]
`history` *`n count`* [command verb]

Shows the command history list with line numbers. When used without arguments, shows entire history. When used with one argument, displays *count* last commands from the history. With two arguments, displays *count* commands starting from *n*th command. Command numbering starts with 1.

This command is available only if GDBM was compiled with GNU Readline. The history is saved in file `.gdbmtool_history` in the user's home directory. If this file exists upon startup, it is read to populate the history. Thus, command history is preserved between `gdbmtool` invocations.

`list` [command verb]

List the contents of the database.

`next` [*`key`*] [command verb]

Sequential access: fetch and display the next record. If the *key* is given, the record following the one with this key will be fetched.

Issuing several `next` commands in row is rather common. A shortcut is provided to facilitate such use: if the last entered command was `next`, hitting the ***`Enter`*** key repeats it without arguments.

See also `first`, above.

See Chapter 10 [Sequential], page 11, for more information on sequential access.

`open` *`filename`* [command verb]

Open the database file *filename*. If successful, any previously open database is closed. Otherwise, if the operation fails, the currently opened database remains unchanged.

This command takes additional information from the following variables:

'`open`' The database access mode. See [The *open* variable], page 39, for a list of its values.

'`lock`' Whether or not to lock the database. Default is '`on`'.

'`mmap`' Use the memory mapping. Default is '`on`'.

'`sync`' Synchronize after each write. Default is '`off`'.

'`filemode`'
Specifies the permissions to use in case a new file is created.

See [open parameters], page 39, for a detailed description of these variables.

`quit` [command verb]
Close the database and quit the utility.

`reorganize` [command verb]
Reorganize the database (see Chapter 11 [Reorganization], page 13).

`source` *`filename`* [command verb]
Read `gdbmtool` commands from the file *filename*.

`status` [command verb]
Print current program status. The following example shows the information displayed:

```
Database file: junk.gdbm
Database is open
define key string
define content string
```

The two '`define`' strings show the defined formats for key and content data. See Section 21.2.3 [definitions], page 43, for a detailed discussion of their meaning.

`store` *`key data`* [command verb]
Store the *data* with *key* in the database. If *key* already exists, its data will be replaced.

`version` [command verb]
Print the version of `gdbm`.

21.2.3 Data Definitions

GDBM databases are able to keep data of any type, both in the key and in the content part of a record. Quite often these data are structured, i.e. they consist of several fields of various types. `Gdbmtool` provides a mechanism for handling such kind of records.

The `define` command defines a record structure. The general syntax is:

```
define what definition
```

where *what* is '`key`' to defining the structure of key data and '`content`' to define the structure of the content records.

The *definition* can be of two distinct formats. In the simplest case it is a single data type. For example,

```
define content int
```

defines content records consisting of a single integer field. Supported data types are:

char Single byte (signed).

short Signed short integer.

ushort Unsigned short integer.

int Signed integer.

unsigned
uint — Unsigned integer.

long — Signed long integer.

ulong — Unsigned long integer.

llong — Signed long long integer.

ullong — Unsigned long long integer.

float — A floating point number.

double — Double-precision floating point number.

string — Array of bytes.

stringz — Null-terminated string, trailing null being part of the string.

All numeric data types (integer as well as floating point) have the same respective widths as in C language on the host where the database file resides.

The '`string`' and '`stringz`' are special. Both define a string of bytes, similar to '`char x[]`' in C. The former defines an array of bytes, the latter - a null-terminated string. This makes a difference, in particular, when the string is the only part of datum. Consider the following two definitions:

1. `define key string`
2. `define key stringz`

Now, suppose we want to store the string "ab" in the key. Using the definition (1), the `dptr` member of GDBM `datum` will contain two bytes: '`a`', and '`b`'. Consequently, the `dsize` member will have the value 2. Using the definition (2), the `dptr` member will contain three bytes: '`a`', '`b`', and ASCII 0. The `dsize` member will have the value 3.

The definition (1) is the default for both key and content.

The second form of the `define` statement is similar to the C `struct` statement and allows for defining structural data. In this form, the *definition* part is a comma-separated list of data types and variables enclosed in curly braces. In contrast to the rest of `gdbm` commands, this command is inherently multiline and is terminated with the closing curly brace. For example:

```
define content {
        int status,
        pad 8,
        char id[3],
        string name
}
```

This defines a structure consisting of three members: an integer `status`, an array of 8 bytes `id`, and a null-terminated string `name`. Notice the `pad` statement: it allows to introduce padding between structure members. Another useful statement is `offset`: it specifies that the member following it begins at the given offset in the structure. Assuming the size of `int` is 8 bytes, the above definition can also be written as

```
define content {
        int status,
        offset 16,
        char id[3],
        string name
}
```

NOTE: The '`string`' type can reasonably be used only if it is the last or the only member of the data structure. That's because it provides no information about the number of elements in the array, so it is interpreted to contain all bytes up to the end of the datum.

When displaying the structured data, `gdbmtool` precedes each value with the corresponding field name and delimits parts of the structure with the string defined in the '`delim1`' variable (see Section 21.2.1 [variables], page 38). Array elements are delimited using the string from '`delim2`'. For example:

```
gdbmtool> fetch foo
status=2,id={ a, u, x },name="quux"
```

To supply a structured datum as an argument to a `gdbmtool` command, use the same notation, but without field names, e.g.:

```
gdbmtool> hash { 2, {a,u,x}, "quux" }
hash value = 13089969.
```

21.2.4 Startup Files

Upon startup `gdbmtool` looks for a file named '`.gdbmtoolrc`' first in the current working directory and, if not found, in the home directory of the user who started the command.

If found, this file is read and interpreted as a list of `gdbmtool` commands. This allows you to customize the program behavior.

Following is an example startup file which disables the welcome banner, sets command line prompt to contain the name of the database file in parentheses and defines the structure of the database content records:

```
set quiet
set ps1="(%f) "
define key stringz
define content {
        int time,
        pad 4,
        int status
}
```

22 The gdbm_dump utility

The `gdbm_dump` utility creates a flat file dump of a GDBM database (see Chapter 13 [Flat files], page 15). It takes one mandatory argument: the name of the source database file. The second argument, if given, specifies the name of the output file. If not given, `gdbm_dump` will produce the dump on the standard output.

For example, the following invocation creates a dump of the database `file.db` in the file `file.dump`:

```
$ gdbm_dump file.db file.dump
```

By default the utility creates dumps in ASCII format (see Chapter 13 [Flat files], page 15). Another format can be requested using the `--format` (`-H`) option.

The `gdbm_dump` utility understands the following command line options:

`-H` *fmt*
`--format=`*fmt*
: Select output format. Valid values for *fmt* are: '`binary`' or '`0`' to select binary dump format, and '`ascii`' or '`1`' to select ASCII format.

`-h`
`--help`
: Print a concise help summary.

`-V`
`--version`
: Print program version and licensing information and exit.

`--usage`
: Print a terse invocation syntax summary along with a list of available command line options.

23 The gdbm_load utility

The gdbm_load utility restores a GDBM database from a flat file. The utility requires at least one argument: the name of the input flat file. If it is '-', the standard input will be read. The format of the input file is detected automatically.

By default the utility attempts to restore the database under its original name, as stored in the input file. It will fail to do so if the input is in binary format. In that case, the name of the database must be given as the second argument.

In general, if two arguments are given the second one is treated as the name of the database to create, overriding the file name specified in the flat file.

The utility understands the following command line arguments:

`-b` *num*
`--block-size=`*num*
: Sets block size. See Chapter 4 [Open], page 4.

`-c` *num*
`--cache-size=`*num*
: Sets cache size. See Chapter 16 [Options], page 23.

`-M`
`--mmap`
: Use memory mapping.

`-m` *mode*

`--mode=`*mode*
: Sets the file mode. The argument is the desired file mode in octal.

`-n`
`--no-meta`
: Do not restore file meta-data (ownership and mode) from the flat file.

`-r`
`--replace`
: Replace existing keys.

`-u` *user*`[:`*group*`]`
`--user=`*user*`[:`*group*`]`
: Set file owner. The *user* can be either a valid user name or UID. Similarly, the *group* is either a valid group name or GID. If *group* is not given, the main group of *user* is used.

  User and group parts can be separated by a dot, instead of the colon.

`-h`
`--help`
: Print a concise help summary.

`-V`
`--version`
: Print program version and licensing information and exit.

`--usage`
: Print a terse invocation syntax summary along with a list of available command line options.

24 Export a database into a portable format.

The `gdbmexport` utility converts the database of an older GDBM version into a binary flat format.

The utility takes two mandatory arguments: the name of the database file to convert and the output file name, e.g.:

```
$ gdbmexport junk.gdbm junk.flat
```

In addition the following two options are understood:

`-h` Display short usage summary and exit.

`-v` Display program version and licensing information, and exit.

25 Exit codes

All GDBM utilities return uniform exit codes. These are summarized in the table below:

Code	Meaning
0	Successful termination.
1	A fatal error occurred.
2	Program was unable to restore file ownership or mode.
3	Command line usage error.

26 Problems and bugs.

If you have problems with GNU `dbm` or think you've found a bug, please report it. Before reporting a bug, make sure you've actually found a real bug. Carefully reread the documentation and see if it really says you can do what you're trying to do. If it's not clear whether you should be able to do something or not, report that too; it's a bug in the documentation!

Before reporting a bug or trying to fix it yourself, try to isolate it to the smallest possible input file that reproduces the problem. Then send us the input file and the exact results `gdbm` gave you. Also say what you expected to occur; this will help us decide whether the problem was really in the documentation.

Once you've got a precise problem, send e-mail to `bug-gdbm@gnu.org`.

Please include the version number of GNU `dbm` you are using. You can get this information by printing the variable `gdbm_version` (see Chapter 18 [Variables], page 27).

Non-bug suggestions are always welcome as well. If you have questions about things that are unclear in the documentation or are just obscure features, please report them too.

You may contact the authors and maintainers by e-mail:

`phil@cs.wwu.edu`, `downsj@downsj.com`, `gray@gnu.org.ua`

27 Additional resources

For the latest updates and pointers to additional resources, visit http://www.gnu.org/software/gdbm.

In particular, a copy of gdbm documentation in various formats is available online at http://www.gnu.org/software/gdbm/manual.html.

Latest versions of gdbm can be downloaded from anonymous FTP: ftp://ftp.gnu.org/gnu/gdbm, or via HTTP from http://ftp.gnu.org/gnu/gdbm, or from any GNU mirror worldwide. See http://www.gnu.org/order/ftp.html, for a list of mirrors.

To track gdbm development, visit http://puszcza.gnu.org.ua/projects/gdbm.

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